Practitioner's Docket No. 442-008040-US(PAR) ***PATENT***

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Jari HAMALAINEN, Kari MALMIVIRTA, Petri JARVINEN, Jarkko OKSALA, Jarno KNUUTILA, Ari SALMINEN, Arto LEPPISAARI

WARNING: Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b).

For (title): TIME DIVISION MULTIPLE ACCESS RADIO SYSTEMS

CERTIFICATION UNDER 37 C.F.R. 1.10*
*(Express Mail label number is **mandatory**.)*
(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date June 17, 1998, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL067096840US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Maureen B. Egan
(type or print name of person mailing paper)

M B Egan
Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

WARNING: Each paper or fee filed by "Express Mail" **must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).*
*"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.*

1. Type of Application

This new application is for a(n)

(check one applicable item below)

- [x] Original (nonprovisional)
- [ ] Design
  - [ ] Plant

WARNING: ***Do not*** *use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.*

WARNING: ***Do not*** *use this transmittal for the filing of a provisional application.*

NOTE: If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- [ ] Divisional.
- [ ] Continuation.
- [ ] Continuation-in-part (C-I-P).

2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

WARNING: If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20–year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c–i–p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

WARNING: When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- [ ] The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed That Are Required for Filing Date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

- 5 Pages of specification
- 1 Pages of claims
- 1 Pages of Abstract
- 1 Sheets of drawing
  - [ ] formal
  - [ ] informal

WARNING: ***DO NOT*** *submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).*

NOTE: "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page." 37 C.F.R. 1.84(c)).

(complete the following, if applicable)

☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).

4. Additional papers enclosed

☒ Preliminary Amendment

☒ Information Disclosure Statement (37 C.F.R. 1.98)

☒ Form PTO–1449 (PTO/SB/08A and 08B)

☒ Citations

☐ Declaration of Biological Deposit

☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.

☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

☐ Special Comments

☐ Other

5. Declaration or oath

☒ Enclosed

Executed by

(check **all** *applicable boxes)*

☒ inventor(s).

☐ legal representative of inventor(s). 37 CFR 1.42 or 1.43.

☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. See item 13 below for fee.

☐ Not Enclosed.

WARNING: Where the filing is a completion in the U.S. of an International Application, but where a declaration is not available, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

☐ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of *all* the above named inventor(s).

(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).

NOTE: It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

☐ Showing that the filing is authorized.
(not required unless called into question. 37 CFR 1.41(d))

6. Inventorship Statement

WARNING: *If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.*

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of $130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(b).

☒ English

☐ Non-English

☐ The attached translation is a verified translation. 37 C.F.R. 1.52(d).

8. Assignment

☒ An assignment of the invention to Nokia Mobile Phones Limited

☒ is attached. A separate ☒ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters-one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

WARNING: *A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.*

9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Finland	972724	June 24, 1997
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☒ is (are) attached.

☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 C.F.R. 1.16)

A. ☒ Regular application

CLAIMS AS FILED			
Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. 1.16(a) $790.00
Total Claims (37 CFR 1.16(c)) 6 − 20 = 0	×	$ 22.00	
Independent Claims (37 CFR 1.16(b)) 3 − 3 = 0	×	$ 82.00	
Multiple dependent claim(s), if any (37 CFR 1.16(d))	+	$270.00	

☐ Amendment cancelling extra claims is enclosed.

☒ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation $ 790.00

B. ☐ Design application
($330.00—37 CFR 1.16(f))

Filing Fee Calculation $_____

C. ☐ Plant application
($540.00—37 CFR 1.16(g))

Filing fee calculation $_____

11. **Small Entity Statement(s)**

☐ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

WARNING: "Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121 or 365(c) of a prior application may rely on a verified statement filed in the prior application if the nonprovisional application includes a reference to a verified statement in the prior application or includes a copy of the verified statement filed in the prior application if status as a small entity is still proper and desired." 37 C.F.R. § 1.28(a).

(complete the following, if applicable)

☐ Status as a small entity was claimed in prior application

_____ / _____, filed on _____, from which benefit is being claimed for this application under:

35 U.S.C. ☐ 119(e),
☐ 120,
☐ 121,
☐ 365(c),

and which status as a small entity is still proper and desired.

☐ A copy of the verified statement in the prior application is included.

Filing Fee Calculation (50% of **A**, **B** or **C** above)

$_____

NOTE: Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

12. **Request for International-Type Search** (37 C.F.R. 1.104(d))

(complete, if applicable)

☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.
(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee $ 790.00

☒ Recording assignment
($40.00; 37 C.F.R. 1.21(h))
(See attached "COVER SHEET FOR ASSIGNMENT ACCOMPANYING NEW APPLICATION".) $ 80.00 (2 cover sheets)

☐ Petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached
($130.00; 37 C.F.R. 1.47 and 1.17(h)) $ _____

☐ For processing an application with a specification in a non-English language
($130.00; 37 C.F.R. 1.52(d) and 1.17(k)) $ _____

☐ Processing and retention fee
($130.00; 37 C.F.R. 1.53(d) and 1.21(l)) $ _____

☐ Fee for international-type search report
($40.00; 37 C.F.R. 1.21(e)) $ _____

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(d).

Total fees enclosed $ 870.00

14. Method of Payment of Fees

☒ Check in the amount of $ 870.00

☐ Charge Account No. _____ in the amount of $_____.

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing, the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 16-1350 :

- ☒ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)
- ☒ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☒ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)
- ☒ 37 C.F.R. 1.17 (application processing fees)

WARNING: While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a), this authorization should be made only with the knowledge that: "Submission of the appropnate extension fee under 37 C.F.R. 1.136(a) is to no avail unless a request or petition for extension is filed." (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).

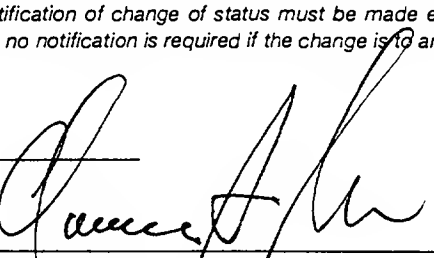
- ☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

NOTE: 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions as to Overpayment

- ☒ Credit Account No. 16-1350
- ☐ Refund



SIGNATURE OF PRACTITIONER

Reg. No. 24,622

Clarence A. Green

(type or print name of attorney)

Tel. No. (203) 259-1800

PERMAN & GREEN, LLP

P.O. Address

Customer No.

425 Post Road, Fairfield, CT 06430

☐ **Incorporation by reference of added pages**

(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)

☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added _____

☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added _____

☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added _____

☒ **Statement Where No Further Pages Added**

(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)

☒ This transmittal ends with this page.

IN THE UNITED STATE PATENT AND TRADEMARK OFFICE

Express Mail No. EL067096840US

In re Application of : HAMALAINEN et al.

SERIAL NUMBER: EXAMINER:

FILING DATE: Herewith ART UNIT:

TITLE: TIME DIVISION MULTIPLE ACCESS RADIO SYSTEMS

ATTORNEY DOCKET NO.: 442-008040-US(PAR)

The Commissioner of Patents and Trademarks

Washington, D. C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the above-identified, enclosed patent application as follows:

IN THE CLAIMS:

Please amend Claims 3 and 4 as shown below.

Claim 3, line 1, delete "or claim 2".

Claim 4, line 1, delete " or 2".

REMARKS

Prior to calculation of the fees, please enter this preliminary amendment.

Respectfully submitted,

6-17-98

Clarence A. Green, Reg. No. 24,622 Date

PERMAN & GREEN, LLP
425 Post Road
Fairfield, CT 06430
(203) 259-1800

TIME DIVISION MULTIPLE ACCESS RADIO SYSTEMS

FIELD OF THE INVENTION

The present invention relates to time division multiple access radio systems and more particularly to time division multiple access radio systems which have multi-slot capabilities.

BACKGROUND OF THE INVENTION

Many existing digital wireless or mobile telephone networks make use of time division multiple access (TDMA) to share out radio resources between a number of mobile stations and between a number of channels. For example, in the European Telecommunications Standards Institute (ETSI) GSM standard, a given frequency band is divided in the time domain into a succession of frames, known as TDMA (Time Division Multiplexed Access) frames. The length of a TDMA frame is 4.615ms. Each TDMA frame is in turn divided into eight consecutive slots of equal duration. In the conventional circuit switched transmission mode, when a call is initiated, a full rate bidirectional traffic channel (TCH/F) is defined for that call by reserving two time slots (1 to 8), in each of a succession of TDMA frames, for the duration of the call. One of these slots provides the downlink from the base station (BS) to the mobile station MS) whilst the other provides the uplink.

The circuit switched transmission mode in GSM provides for a data transmission rate of 9.6kbps. However, due to the demand for higher transmission rates, a set of GSM enhancements known as GSM Phase 2+ have been specified by ETSI. One of the main features of GSM Phase 2+ is known as High Speed Circuit Switched Data (HSCSD - specified in GSM 02.34 and GSM 03.34) which achieves an increased data transmission rate by using more than one TCH/F for a single connection (i.e. effectively reserving two or more consecutive time slots in each TDMA frame).

GSM Phase 2+ also specifies (see for example GSM 01.60, 02.60, 03.60, and 03.64) a new feature known as General Packet Radio Service (GPRS). GPRS provides for the dynamic allocation of radio resources, with the allocation for uplink and downlink communications being made separately and independently of each other. That is to say that a time slot is allocated to a particular MS to BSS link only when there is data to be transmitted. The unnecessary reservation of a TCH/F, when there is no data to

be transmitted, is thus avoided. In addition, a high speed packet switched transmission channel may be provided by assigning two or more slots in each of a succession of TDMA frames to a single MS.

In the current GSM standard, because only a single time slot in each TDMA frame can be reserved for the uplink channel, and similarly for the downlink channel, it is easy to keep the two reserved slots separated in time so that a single radio module can be used, in the MS, for both transmission and reception. This module can also be used for monitoring the radio conditions in the serving cell and in neighbouring cells. However, with the introduction of HSCSD and GPRS where the number of reserved slots in a TDMA frame is variable, if slots are reserved for both uplink and downlink transmission in the same TDMA frame then there exists the possibility that uplink and downlink slots will overlap in time. Communication is then 'full-duplex' and it is necessary to provide separate radio modules for transmission, reception, and monitoring, i.e. a total of three radio modules. The preferred option is therefore to use only 'half-duplex' communication where uplink and downlink transmissions are made in alternate TDMA frames. The possibility for uplink and downlink transmissions to overlap is therefore eliminated as is the need for separate radio modules in the MS. Current proposals are for symmetric uplink and downlink resource allocation where the same number of time slots in alternate frames are reserved for both uplink and downlink transmissions.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a method of operating a time division multiple access (TDMA) radio system having multi-slot capabilities and utilising half-duplex transmission/reception where uplink and downlink user data transmissions between a mobile station (MS) and a base station (BS) are made in separate TDMA frames, the method comprising allocating a greater number of time slots in each downlink TDMA frame than in each uplink TDMA frame, to said mobile station.

This asymmetric allocation of resources is possible because the amount of data transferred over the downlink is, in general, considerably greater than that transferred over the uplink. For example, where the MS is used to access the Internet. The present invention gives rise to a number of significant advantages over

the previously proposed symmetric allocation. Firstly, because the MS is transmitting over fewer time slots, the implementation of the power amplifier of the radio module is made simpler. Power losses are reduced as, consequently, are heat sink requirements. Secondly, power consumption is reduced increasing the stand-by and active operating times of the MS and making the selection of appropriate batteries easier. Thirdly, the price of the mobile station is reduced.

Preferably, the uplink and downlink TDMA frames are provided by alternate TDMA frames of a selected frequency band. The TDMA radio system may utilise GPRS or HSCSD protocols. However, other suitable protocols may also be used.

Embodiments of the invention may make use of four time slots for the downlink and two time slots for the uplink. However, any other suitable combination may be used.

According to a second aspect of the present invention there is provided a time division multiple access (TDMA) radio system having multi-slot capabilities and utilising half-duplex transmission/reception where uplink and downlink user data transmissions between a mobile station (MS) and a base station (BS) are made in separate TDMA frames, the system comprising control means capable of allocating a greater number of time slots in each downlink TDMA frame than in each uplink TDMA frame, to said mobile station.

According to a third aspect of the present invention there is provided a mobile communication device arranged to operate in a time division multiple access (TDMA) radio system having multi-slot capabilities, the mobile communication device comprising a radio module utilising half-duplex transmission/reception where uplink and downlink user data transmissions between the mobile communication device and a base station (BS) are made in separate TDMA frames, wherein a greater number of time slots may be allocated in each downlink TDMA frame than in each uplink TDMA frame, to the mobile communication device.

BRIEF DESCRIPTION OF THE INVENTION

For a better understanding of the present invention and in order to show how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows schematically a GSM mobile telephone network and a mobile station in communication with the network; and

Figure 2 shows schematically uplink and downlink transmissions between a base station of the GSM network and the mobile station.

DETAILED DESCRIPTION

There is illustrated in Figure 1 a cell 1 of a cellular mobile telephone network. A mobile station (or telephone) 2 located within the cell 1 communicates with a base station (BS) 3 of the cell. As has already been described above, when a call or data connection is made from the mobile station 2 to the BS 3 or *vice versa*, a downlink 'channel' and an uplink 'channel' are reserved to enable bi-directional communication to take place. Both of these channels are in the same frequency band and each consists of a plurality of time slots reserved in every other TDMA frame.

This is illustrated in Figure 2 where the upper diagram illustrates the time slots (2 and 3) reserved for the uplink channel, i.e. for user data transmission from the MS 2 to the BSS 3, MS TX, and the lower diagram illustrates the time slots (3 to 6) reserved for the downlink channel, i.e. for user data reception by the MS 2, MS RX. The TDMA frames (TX and RX frames) of the uplink and downlink channels are interlaced so that the frames alternate between uplink and downlink channels. In this way, regardless of the number or location of slots reserved for either the uplink or downlink channels, the reserved slots will not overlap in time. The MS 2 can therefore be provided with a single radio module 4 which performs both transmission and reception functions.

Furthermore, the number of time slots reserved in any one TDMA frame for the downlink channel is generally greater than the number of channels reserved for the uplink channel (although the system may also be capable of operating in a symmetric allocation mode where the number of slots allocated for reception and transmission are the same). This represents a new multi-slot class for TDMA radio systems. In the example shown in Figure 2, two time slots are allocated to the MS 2 in each of the uplink TDMA frames and four time slots are allocated in each of the downlink frames. As already explained above, higher data transmission rates are generally required for the downlink than are required for the uplink. The asymmetry

of time slot allocation tends to increase the efficiency of radio resource allocation and also results in power saving and other efficiencies in the MS 2.

It will be appreciated by the person of skill in the art that modifications may be made to the above described embodiment without departing from the scope of the present invention. In one modification, the uplink and downlink TDMA frames need not be contiguous. For example, one frame in four may be allocated to the uplink and one frame in four (or one frame in two) allocated to the downlink, provided that the uplink and downlink frames do not overlap.

Whilst the invention relates to the transmission and reception of user data, it is noted that transmission and reception of signalling data may take place in the same TDMA frame and in the same TDMA frame as either transmission or reception of user data.

CLAIMS

1. A method of operating a time division multiple access (TDMA) radio system having multi-slot capabilities and utilising half-duplex transmission/reception where uplink and downlink user data transmissions between a mobile station and a base station are made in separate TDMA frames, the method comprising allocating a greater number of time slots in each downlink TDMA frame than in each uplink TDMA frame, to said mobile station.

2. A method according to claim 1, wherein the TDMA frames alternate between reception and transmission frames.

3. A method according to claim 1 or claim 2, wherein the TDMA radio system utilises the GPRS protocol.

4. A method according to claim 1 or 2, wherein the TDMA radio system utilises the HSCSD protocol.

5. A time division multiple access (TDMA) radio system having multi-slot capabilities and utilising half-duplex transmission/reception where uplink and downlink user data transmissions between a mobile station and a base station are made in separate TDMA frames, the system comprising control means capable of allocating a greater number of time slots in each downlink TDMA frame than in each uplink TDMA frame, to said mobile station.

6. A mobile communication device arranged to operate in a time division multiple access (TDMA) radio system having multi-slot capabilities, the mobile communication device comprising a radio module utilising half-duplex transmission/reception where uplink and downlink user data transmissions between the mobile communication device and a base station are made in separate TDMA frames, wherein a greater number of time slots may be allocated in each downlink TDMA frame than in each uplink TDMA frame, to the mobile communication device.

ABSTRACT

A method of operating a time division multiple access (TDMA) radio system having multi-slot capabilities and utilising half-duplex transmission/reception where uplink and downlink user data transmissions between a mobile station (MS) 2 and a base station (BS) 3 are made in separate TDMA frames. A greater number of time slots are allocated to the mobile station 2 in each downlink TDMA frame than in each uplink TDMA frame to improve the efficiency of radio resource allocation and of the radio module 4 of the mobile station 2.

Figure 2

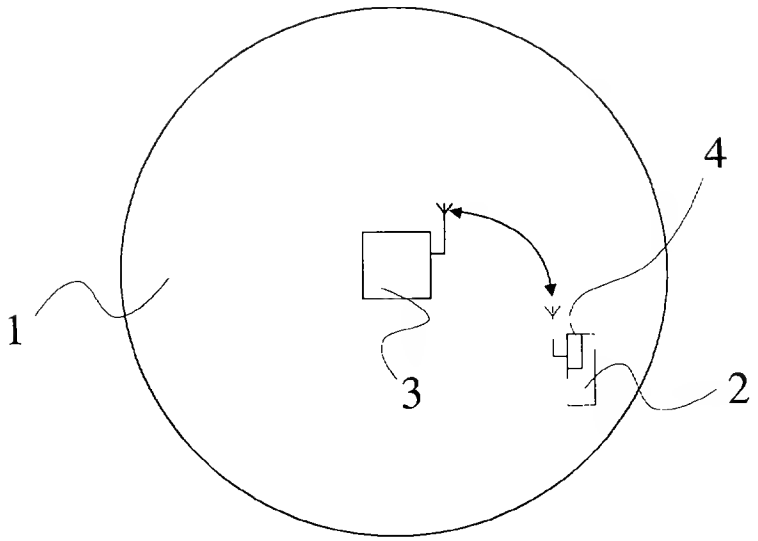


Figure 1

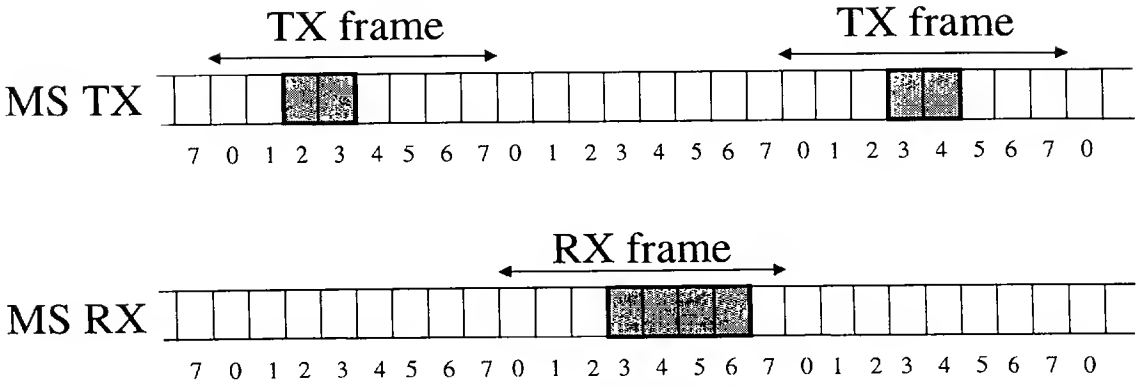


Figure 2

Attorney's Docket No. _____ **PATENT**

COMBINED DECLARATION AND POWER OF ATTORNEY

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL, CONTINUATION OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type: (check one applicable item below)

☒ original
☐ design
☐ supplemental

NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.

☐ national stage of PCT

NOTE: if one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.

☐ divisional
☐ continuation
☐ continuation-in-part (C-I-P)

INVENTORSHIP IDENTIFICATION

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below next to my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

Time Division Multiple Access Radio Systems

SPECIFICATION IDENTIFICATION

the specification of which: (complete (a), (b) or (c))

(a) ☒ is attached hereto.
(b) ☐ was filed on _____ as ☐ Serial No. 0 /
or ☐ Express Mail No., as Serial No. not yet known
and was amended on _____(if applicable)

NOTE. Amendments filed after the original papers are deposited with the PTO which contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

(c) ☐ was described and claimed in PCT International Application No. _____ filed on _____ and as amended under PCT Article 19 on _____(*if any*).

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information

☒ which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56

(also check the following items, if desired)

☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent, and

☐ In compliance with this duty there is attached an information disclosure statement in accordance with 37 CFR 1.98.

PRIORITY CLAIM (35 U.S.C. § 119)

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT International application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT International application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (d) or (e))

(d) ☐ no such applications have been filed.

(e) ☒ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

A. PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, **month**, year)	PRIORITY CLAIMED UNDER 37 USC 119
Finland	**972724**	**24.06.1997**	☒ **YES** **NO**☐
			☐ **YES** **NO**☐
			☐ **YES** **NO**☐
			☐ **YES** **NO**☐
			☐ **YES** **NO**☐

ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS (6) MONTHS FOR DESIGN PRIOR TO THIS U.S. APPLICATION

_____

_____

_____

NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

POWER OF ATTORNEY

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(List name and registration number)*

Clarence A. Green (24,622)
Harry F. Smith (32,493)
Mark F. Harrington (31,686)

(check the following item, if applicable)

☐ Attached as part of this declaration and power of attorney is the authorization of the above-named attorney(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

Perman & Green
425 Post Road
Fairfield, CT 06430-6232

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)
Mark F. Harrington

(203) 259-1800

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor

Jari (GIVEN NAME) — (MIDDLE INITIAL OR NAME) HÄMÄLÄINEN (FAMILY (OR LAST NAME))

Inventor's signature _____

Date 25.5.1998 Country of Citizenship Finland

Residence ~~Matti Tapion katu 1 G 17, FIN-33720 Tampere, Finland~~ Nallekarhuntie 20, FIN-36100 Kangasala as, Finland

Post Office Address ~~Matti Tapion katu 1 G 17, FIN-33720 Tampere, Finland~~

JH.e 25.5.98

Full name of second joint inventor, if any

Petri (GIVEN NAME) — (MIDDLE INITIAL OR NAME) JÄRVINEN (FAMILY (OR LAST NAME))

Inventor's signature _____

Date 26.5.1998 Country of Citizenship Finland

Residence Insinöörinkatu 46 B 31, FIN-33720 Tampere, Finland

Post Office Address Insinöörinkatu 46 B 31, FIN-33720 Tampere, Finland

---

Full name of third joint inventor, if any

Jarno		KNUUTILA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____ 27.05.98

Date 27 05. 1998 Country of Citizenship Finland

Residence ~~Opinpolku 1 A 9, FIN 33720 Tampere, Finland~~ Matt. Tapion katu 1 F17

Post Office ~~Address Opinpolku 1 A 9, FIN-33720 Tampere, Finland~~ FIN-33720 Tampere, Finland

CHECK PROPER BOX(ES) FOR ANY OF THE FOLLOWING ADDED PAGE(S) WHICH FORM A PART OF THIS DECLARATION

☒ Signature for fourth and subsequent joint inventors. *Number of pages added* 1 .

• • •

☐ Signature by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added*

• • •

☐ Signature for inventor who refuses to sign or cannot be reached by person authorised under 37 CFR 1.47. *Number of pages added*

• • •

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☐ Number of pages added

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☐ Authorization of attorney(s) to accept and follow instructions from representative.

• • •

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☐ This declaration ends with this page.

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name as it should appear on the filing receipt and all other documents.

Full name of fourth inventor, if any

Arto	_____	LEPPISAARI
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Teekkarinkatu 7 C 50, FIN-33720 Tampere, Finland
Post Office Address Teekkarinkatu 7 C 50, FIN-33720 Tampere, Finland

---

Full name of fifth joint inventor, if any

Kari	_____	MALMIVIRTA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date 26.5.1998 Country of Citizenship Finland
Residence Insinöörinkatu 60 A 11, FIN-33720 Tampere, Finland
Post Office Address Insinöörinkatu 60 A 11, FIN-33720 Tampere, Finland

---

Full name of sixth joint inventor, if any

Jarkko	_____	OKSALA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date 29.5.1998 Country of Citizenship Finland
Residence Näyttelijänkatu 21 A, FIN-33720 Tampere, Finland
Post Office Address Näyttelijänkatu 21 A, FIN-33720 Tampere, Finland

---

Full name of seventh joint inventor, if any

Ari	_____	SALMINEN
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date 27.5.1998 Country of Citizenship Finland
Residence Turuntie 26 A 3, FIN-24240 Salo, Finland
Post Office Address Turuntie 26 A 3, FIN-24240 Salo, Finland

Attorney's Docket No. _____ **PATENT**

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			☐ **YES** **NO**☐
			☐ **YES** **NO**☐
			☐ **YES** **NO**☐
			☐ **YES** **NO**☐

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Harry F. Smith (32,493)
Mark F. Harrington (31,686)

(check the following item, if applicable)

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Fairfield, CT 06430-6232

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(Name and telephone number)
Mark F. Harrington

(203) 259-1800

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SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor

Jari	___	HÄMÄLÄINEN
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Matti Tapion katu 1 G 17, FIN-33720 Tampere, Finland
Post Office Address Matti Tapion katu 1 G 17, FIN-33720 Tampere, Finland

Full name of second joint inventor, if any

Petri	___	JÄRVINEN
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Insinöörinkatu 46 B 31, FIN-33720 Tampere, Finland
Post Office Address Insinöörinkatu 46 B 31, FIN-33720 Tampere, Finland

Full name of third joint inventor, if any

Jarno	_____	KNUUTILA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Opinpolku 1 A 9, FIN-33720 Tampere, Finland
Post Office Address Opinpolku 1 A 9, FIN-33720 Tampere, Finland

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☒ Signature for fourth and subsequent joint inventors. *Number of pages added* 1 .

...

☐ Signature by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added*

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☐ Signature for inventor who refuses to sign or cannot be reached by person authorised under 37 CFR 1.47. *Number of pages added*

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SIGNATURE(S)

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Full name of fourth inventor, if any

Arto		LEPPISAARI
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date 30th May 1998 Country of Citizenship Finland
Residence ~~Teekkarinkatu 7 C 50, FIN-33720 Tampere, Finland~~ Satakunnankatu 5 A 25, FIN-33100 Tampere
Post Office Address ~~Teekkarinkatu 7 C 50, FIN-33720 Tampere, Finland~~ Satakunnankatu 5 A 25 FIN-33100 Tampere
30 5 98

Full name of fifth joint inventor, if any

Kari		MALMIVIRTA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Insinöörinkatu 60 A 11, FIN-33720 Tampere, Finland
Post Office Address Insinöörinkatu 60 A 11, FIN-33720 Tampere, Finland

---

Full name of sixth joint inventor, if any

Jarkko		OKSALA
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Näyttelijänkatu 21 A, FIN-33720 Tampere, Finland
Post Office Address Näyttelijänkatu 21 A, FIN-33720 Tampere, Finland

---

Full name of seventh joint inventor, if any

Ari		SALMINEN
(GIVEN NAME)	(MIDDLE INITIAL OR NAME)	FAMILY (OR LAST NAME)

Inventor's signature _____
Date _____ Country of Citizenship Finland
Residence Turuntie 26 A 3, FIN-24240 Salo, Finland
Post Office Address Turuntie 26 A 3, FIN-24240 Salo, Finland